

REMARKS

The Office Action mailed October 17, 2007, has been received and its contents carefully noted. The active claims, claims 1-8 and 14-16, were rejected. By this Response, claims 1 and 14 have been amended. Support may be found in the original application as filed. No statutory new matter has been added. Therefore, reconsideration and entry of the claims, as amended, are respectfully requested.

Rejection under 35 U.S.C. 103(a)

The Examiner rejected claims 1, 2 and 15 under 35 U.S.C. 103(a) as being unpatentable over US 20030080091 to Nakaune in view of US 6,593,246 to Hasegawa and Ono, Pure and Applied Chemistry, Vol. 66, No. 6 (1994). The Examiner rejected claims 3-8 under 35 U.S.C. 103(a) as being unpatentable over Nakaune in view of Hasegawa and Ono as applied to claims 1 and 2, in further view of US 5,272,417 to Ohmi. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakaune in view of US 20040206725 to Fuse, Hasegawa and Ono. The Examiner rejected claim 16 under 35 U.S.C. 103(a) as being unpatentable over Nakaune in view of Hasegawa and Ono as applied to claim 1 above, and further in view of US 20020108929 to Ho.

As now clarified in the claims, the invention is directed to the generation of plasma by using an ionization accelerating mono-atomic gas having a specific ionization energy and a maximum ionization cross-section. By using not only a poly-atomic molecular gas but also an ionization accelerating mono-atomic gas, Applicants' claimed method achieves substantially uniform plasma density, and therefore, substantially uniform etching rate over the entire surface of the substrate.

As a result of the steps in Applicants' claimed method, only one pattern of ionization of the accelerating mono-atomic gas (Ar gas) occurs as follows:

[Atomic ionization]

Mono-atom Ar ->(ionization)Plasma of mono-atom Ar.

Applicants have noted that when using not only the poly-atomic molecular gas but also a sufficient amount of an ionization accelerating mono-atomic gas, e.g. with the flow rate ratio

[mono-atomic gas/poly-atomic molecular gas] of 0.5 or above, plasma of the mono-atomic gas tends to dominate the plasma density. Due to the lighter weight of the mono-atom than that of the poly-atomic molecular, the plasma of the mono-atomic gas distributes relatively uniformly over the substrate. Thus, substantially uniform plasma density, e.g., of at least about $0.5 \times 10^{10} \text{ C}^{-3}$, can be achieved. Therefore, a substantially uniform etching rate over the entire surface of the substrate can be achieved. See Figs. 11, 12, and 13 of the present patent application.

None of the alleged references, alone or in combination, teaches or suggests using a mono-atomic gas in accordance with the present invention, or the advantages of such use. In particular, Ono does not disclose any ionization accelerating mono-atomic gas (e.g. Ar gas) but discloses only a poly-atomic molecular gas (Cl_2 gas). This gives two main patterns of ionization as follows:

[Dissociative ionization]

Poly-atomic molecular Cl_2

(dissociation) --- Mono-atoms Cl

(ionization)- Plasma of mono-atoms Cl.

[Molecular ionization]

Poly-atomic molecular Cl_2

(ionization)- Plasma of poly-atomic molecular Cl_2

According to Applicants, by using a poly-atomic molecular gas such as taught in Ono, plasma density tends to be uneven over the surface of the substrate. Specifically, it tends to be larger above the center part of the substrate and smaller above the edge part thereof. Applicants believe this to be due to:

- (1) a main flow direction of the process gas from the center to the edge of the substrate;
- (2) heavier weight of the poly-atomic molecular than that of the mono-atom; and therefore,
- (3) a larger amount of plasma of poly-atomic molecular present above the substrate center part than that above the edge part thereof.

Thus, plasma etching by using only a poly-atomic molecular gas results in uneven plasma

density, and therefore, uneven etching rate over the surface of the substrate.

Nowhere does Ono, alone or in combination with the asserted references teach or suggest using a mono-atomic gas in order to prevent uneven plasma density and uneven etching as taught by the present invention. For at least these reasons, Applicants respectfully urge that the claims are unobvious and that the rejection under 35 U.S.C. 103(a) should be withdrawn.

Applicants also respectfully point out that Nakaune does not disclose any "ionization energy" for the ionization accelerating gas, but rather discloses "low electron temperature of 0.25 eV to 1 eV" as a mere feature of ECR plasma itself. Applicants respectfully submit that the asserted references do not teach or suggest the ionization energy range of 10 eV or below of the ionization accelerating mono-atomic gas of the present invention. Thus, none of the asserted references discloses or suggests using an ionization accelerating mono-atomic gas having the specified ionization energy and maximum ionization cross-section as now claimed.

Therefore, Applicants respectfully urge that the claims are unobvious and the rejection under 35 U.S.C. 103(a) must be withdrawn.

Request for Interview

Applicants respectfully request either a telephonic or an in-person interview should there be any remaining issues.

CONCLUSION

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Therefore, it is respectfully requested that the Examiner reconsider all presently outstanding rejections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

It is not believed that extensions of time are required, beyond those that may otherwise be provided for in accompanying documents. However, in the event that additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. 1.136(a), and any fees required therefor are hereby authorized to be charged to **Deposit Account No. 02-4300, Attorney Docket No. 033082M257.**

Respectfully submitted,
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